Status Report: 19
Status as of: 31 May 2002

Contract Title:

BOOSTER APPLICATIONS FACILITY

Performing Organization: Brookhaven Science Associates
Location: Brookhaven National Laboratory
Upton, New York 11973-5000

Reporting Period: April 1, 2002 – May 31, 2002

1) Project Objective:

The purpose of this project is to provide a new experimental facility and beam line and undertake accelerator modifications required to take advantage of heavy-ion beams from the Brookhaven AGS Booster accelerator for radiation effects studies of importance for the NASA Space Program.

Heavy ions will originate in the Brookhaven MP-6 tandem accelerator and be transported to the Booster synchrotron for acceleration to the required energies.

Concurrent operation of the Booster for space radiation research and other kinds of research applications will be achieved by utilizing independent tandem injectors. The beam species and energy for both applications will be independent. Beams from either Tandem will be switched into the common injection line. At the Booster a new slow extraction system will be implemented which will require extensive accelerator modifications and rearrangements. A new beam line and tunnel enclosure will be built to transport the extracted beam to the experimental facility. Uniform beam intensities will be provided over rectangular areas ranging in size from about 1 cm to about 20 cm.

Other existing on-site facilities, such as the medical Department's extensive animal handling installations will also be utilized. Dosimetry and local access control will be provided through a local facility control room.

The conventional facilities to be constructed for the Booster Applications Facility will provide experimental space and support facilities. A labyrinth connects the experimental area with the laboratory support building. The target room is provided with a concrete beam stop imbedded in the back wall. The entire facility is shielded by 15 feet of earth equivalent shielding over the top of the target rooms and transport lines. The laboratory building contains support laboratories, including temporary biological specimen holding and preparation areas, as well as radiological laboratories for work with cell cultures and tissues. Also included are a dosimetry control room, a mechanical service equipment area and rooms for radioactive storage and miscellaneous items.

Power supplies for the beam transport magnets and various other equipment will be located in a power supply building, a pre-engineered steel frame construction.

The funds requested will also provide for spares and facility commissioning.

2) Technical Approach Changes:

No change.

Project Head's Summary Assessment:

	Last Month	This Month
Cost:	satisfactory	satisfactory
Schedule	satisfactory	satisfactory
Technical	satisfactory	satisfactory
Overall	satisfactory	satisfactory

W.B.S. 1.0 BAF Construction Summary: The conventional construction effort is complete except for the work in the stub tunnel and on the Booster berm. Power supply testing is on going and vacuum system installation in the Beam line is proceeding on schedule. All Booster Modification components are complete. Commissioning started this reporting period with the successful acceleration of Fe+20 ions in the Booster. There has been a delay in the deliveries of the D3 septum and the remaining beam line power supplies. This will have no impact on the critical path. The project is estimated to be 80 % complete.

W.B.S 1.1 Conventional Construction: 98 % Complete

Power Supply Building, Experimental Support Building and Tunnel substantially complete and occupied by project Staff. Punch list work in progress. The site work and the utilities are 96% and 100% complete respectively. Balance of site work and tunnel work will be completed upon shutdown of Booster on ~June 15, 2002. Estimated construction completion date - 7/31/02.

W.B.S. 1.2 Booster Modifications: (Critical Path)

1.2.1 New Extraction Equipment: 97 % complete**.**

1.2.1.1 Thin Septum: The magnet has been assembled and passed a high pot test. It is being prepared for Survey and is scheduled for a bake-out June 6. The motion controls have been wired and tested. This WBS is 85% complete.

1.2.1.2 Thick Septum Magnet: The first article magnet and the spare are fully assembled. Field measurement and evaluation of the spare magnet is currently in process. The evaluation of the first article magnet will be conducted at a later date. The first article magnet is currently being baked out under vacuum.

1.2.1.3 Foil Stripper Assembly: The stripper/collimator/flag assembly has been installed in the first article magnet. All wiring is complete. The assembly of the spare is about 60% complete.

1.2.2 Power Supplies: 88 % complete**.**

1.2.2.1 Thin Septum Supply**:** Tests on the completed power supply were witnessed at the vendor, Alpha scientific. Problems were encountered reaching the specified rise time and have delayed shipment until modifications to the control circuits are completed.

1.2.2.2 Ejection Septum Supply: The Power Supply has been received from Alpha Scientific and is being used to power the D6 thick septum magnet for magnetic field measurements. The measurement set up includes the resistance monitoring system for interlocking septum over temperatures.

1.2.2.3 Tune Quads Supplies: Power supply testing has begun.

1.2.2.4 Sextupole: The power supplies have been moved to their final location.

1.2.2.5 Bumps: All power supplies are now in their final location. Power supply modifications and tests are in progress.

1.2.3 Equipment Modifications: 60 % complete.

1.2.3.1 D4 and D6: Parts complete.

1.2.3.2 D6 Beam Dump and Wall Current Monitor: Complete.

1.2.3.3 D3 IPM and Beam Dump Kicker: Design is complete.

1.2.3.4 Vacuum System Modifications: All heating blankets have been received and are ready for installation.

W.B.S. 1.3 <u>Beam Transport System</u>

1.3.1 Magnets: 100% complete.

1.3.2 Power Supplies**:** 75% complete**.**

Nine of the nineteen power supplies purchased from Danfysik have been received, installed and are ready for testing. The status of the remaining power supplies is as follows:

a) 2500Amp-70 volt and 3200Amp-220volt units: Construction has been completed, power supplies must be tested and shipped.

b) 450Amp-20volt units (8 each): An error had been found during testing in the construction of the power transformer. Replacement transformers have been manufactured and power supply production is near completion.

1.3.3 Vacuum System: 70 % complete.

1.3.3.1 Beam Tubes, Bellow and Valves: All vacuum pipes and chambers have been fabricated and or received from vendors. Supports for the all-metal gate valve at extraction and the fast valve are in fabrication. Approximately 70% of the beam line has been installed downstream of bending magnet #2. The dipole chambers have been welded in the magnets and leak checked.

1.3.3.2 Pumps, Power Supplies and Gauges: The turbo roughing pumps stations are now being used for bake-out of parts before installation in the tunnel.

1.3.3.3 Instrumentation and Controls: PLC ladder programming is nearly complete. Ethernet communication with the PLC for remote valve control and status was established. The ion pump and gauge controllers were installed in Building 957 and interlock cable assembly is in progress. PLC interface module pre-wiring was completed.

1.3.3.4 Transport Line Bake-out System: All blankets on order have been received and tested. The bake-out cart assembly has been fabricated and tested.

1.3.4.Instrumentation: 80 % complete.

1.3.4.1 Flags and Cameras: All flag vacuum chambers are assembled; 3 of 4 are installed and

surveyed in the tunnel. New Camera ports have been installed and welded into the beam line tunnel on the wall (non-isle) side to accommodate light shrouds so that emergency lighting will not dominate the CCD cameras.

The Personal Computer, dedicated as a video frame grabber, has been configured. Testing and data transfer effort to the high-level controls continues. We experienced the failure of several Sony 1394 cameras, some have been repaired. One was sent back to Sony for failure analysis. Progress has been made to solve our long-haul 1394 Fire-wire data transport configuration between the transport CCD cameras and the Fire-wire hubs and PC. We have transported the high-speed digital video over 100 feet without repeaters using multiple Belden 9104 CATV cables. We have received the IEEE 1394 to fiber optic links that will ensure data communication over the long distances needed in this application.

1.3.4.2 Collimators and Beam Plug: Assembly of the collimators continues. The beam plug and Be chamber fabrication and leak check is complete. Heater blankets have arrived and bake-out will begin soon.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillators and SWICS:

- Effort continues on the assembly of SWIC electronics. The new prototype SWIC electronics scanner is ready for testing with the VME controls system hardware, we await software configuration of this VME equipment to enable communications via an interface application. The VME chassis (destined for bldg 957) was assembled with all the necessary boards, and delivered to our tech-shop for direct testing with our instrumentation electronics using simulated beam signals.
- Continue development of signal transfer interface between Accelerator and Experimental Area. The C-AD Controls group has accepted responsibility for providing the necessary logic and timing requirements using existing boards (V102 & V128). The controls group is in the process of writing the necessary firmware to download into the VME boards.
- Discussions on high level Controls application requirements for data analysis and display continue.
- We now have the entire Bira High Voltage VME system in house and powered up. Further improvements have been made to the Controls interface application to exercise more of the system capabilities. We are testing the system performance in the tech-shop. The previously returned failed HV pod was replaced, and we have received the spare pods as ordered.
- The racks for building 957 have been installed and powered; we await air conditioning before installing instrumentation electronics to avoid moisture damage to our sensitive circuits.
- Improvements to the ion chamber front-end electronics are under further consideration. We are looking at modifying the current to frequency converter circuit, and an alternative recycling integrator solution using P-Spice simulations.
- The scintillator NIM electronics were tested successfully during the recent AGS NASA Radio-Biology run in the A3 line.
- Three of four of 4 SWIC-Ion-Scintillator vacuum chambers are being installed and surveyed into the beam line tunnel. Motion system testing was successful and will meet repeatability requirements. All Wire planes for SWIC's have been received. Still awaiting delivery or high voltage planes

W.B.S. 1.4 Controls and Personnel Safety System

1.4.1 Controls: 75 % complete.

1.4.1.1 Distributed systems: The permit monitor boards were tested and performed to specification. The fiber from Buildings 911 to 957 has been completed. The fiber termination boxes were installed and the 3U chassis for controls infrastructure was also installed in 957.

1.4.1.2 Central Services: Software development and testing is continuing for power supply and vacuum interfaces. Test platforms are being supported for engineering level testing of instrumentation systems. Application level software development and testing has begun for the Main Magnet system.

1.4.1.3 Process Controls**:** The building 957 controls documentation was updated in preparation for installation. The Power supply control chassis is populated and is ready for installation in 957. All the fiber optic components for power supply control have been purchased.

1.4.2 Personnel Safety System: Installation Continues**.** 92% complete.

W.B.S. 1.5 Experimental Area Outfittng: 80 % complete.

1.5.1 Dosimetry Control:

Software: Work continues on the foundation of the system: Channels for the new ring/quad ion chambers and for the 16 by 16 ion element chamber channels, to support the bias and gain hardware in the recycling integrator VME cards; refinement of various displays; the design document, specifically the chapter on the display sub-system, chapter 11; replacing the Camac crate, station, sub-address, function with VME crate number and address in the channel table load routines.

During the previous reporting period (February and March of 2002) it was reported that the initial version of the document defining the procedure to calibrate the gain and bias in the 16-channel recycling integrator VME cards--for the new ring/quad ion chambers and for the 16 by 16 ion chamber--was complete, and that, based on this document, work had been completed on a set of three programs to handle the fast bias sub-system of the 16-channel recycling integrator VME cards. Testing of these three programs awaits the availability of the hardware.

During the current reporting period, work has been completed on another set of three programs to handle the gain sub-system of the 16-channel recycling integrator VME cards. Testing of these three programs also awaits the availability of hardware. Unlike the three programs for the bias sub-system, it is likely that one of these three programs for the gain sub-system will need some refinement when tested with hardware.

Work has started on a program to create setup files for radiobiology experiments.

Hardware: The Binary Filter Driver chassis and high voltage system and custom VME crates are complete. The cables have been fabricated. The Recycling Integrator module layout was found to have a significant guard structure flaw around the calibration circuitry; some rework must be done before it can be fabricated.

1.5.2 to 4 Support Rooms: We purchased the following for general use. Locking cabinets for key (some drawers in C rooms lock) storage; a liquid nitrogen storage tank, transfer hose and dolly, plus a 10 l liquid nitrogen Dewar; and a refrigerator-freezer (safe for volatiles).

We purchased a remote temperature monitors for incubators and misc. small equipment (water baths, small & large; hotplates) for Room C.

W.B.S. 1.6 <u>Long Term Support Lab</u>: No change: 90 % complete.

W.B.S. 1.7 <u>Installation and Services</u>: 94% complete.

1.7.1 Electric Power Distribution: 95 % complete.

1.7.2 Equipment Cooling Water: 94 % complete

1. Pump alignment is complete
2. Full electrical power is available to turn on all pumps. The motor rotations have been checked and only one motor is reversed. This will be corrected along with two other electrical items to be corrected. After completion of these items we will proceed to check system operations for the tower system, power supply system and the magnet system.
3. The Power Logic Control (PLC) unit has been 100% fabricated and installed. The electrical power and the installation cables between transducers to the PLC have been installed and are being checked out. The PLC and system check out is scheduled for this June.
4. The piping in the tunnel is 90% complete. Only the connection to the Booster Ring remains to be completed and tested. This second Phase is also nearly complete. Final work is expected to start during June.
5. Completion of Power Supply Piping in Bldg 930 has started and is about 50% complete. This now is also on hold until June 02. The underground connect to Bldg 930 and the line to the UEB have been installed and tested. The piping contractor is almost complete with the other PS piping within Bldg 957.
6. The piping contractor is complete with the following work in Bldg #957:
   a. Sump drains to holding tank
   b. Installation of holding tank
   c. Air lines from compressor to tunnel and within tunnel
   d. Compressor installation
   e. Air filter and oil separator installation to air compressor
   f. Connection of c, d, and e above

1.7.3 Installation: The AC, DC & Magnet Interlock cables remain at 95% complete awaiting the Booster shut down. Termination of the above cables is 85% complete.

Commissioning: Weekly meetings were inaugurated on April 10 to discuss BAF commissioning issues. A Lead Physicist was designated, and the charge to the commissioners included that their systems perform correctly for all modes of Booster and BAF operation. In addition, since BAF is scheduled to be

operational on June 30, 2003, commissioners must be concerned that their systems are ready to be handed over to Operations before that date.

There is now a BAF Commissioning web site at http://www.cadops.bnl.gov/AGS/BAF/Commissioners/ This web site will become the repository of the BAF Commissioning documentation.

BAF Commissioning will be done when systems are ready and when scheduling permits. The first scheduled commissioning was performed on April 15 when 15-20 microA Fe21+ was injected into the Booster and Accelerated to approximately 850 MeV per nucleon. Capture and acceleration was carried out with rf harmonic h=4 and 4x 10^8 ions were accelerated to full energy. Previous to this effort, Fe 10+ was the highest charge state of iron accelerated in the Booster

The importance of the success of this effort is that in order to reach the highest energy required for BAF, high charge state Fe is needed because of the limitations on magnetic rigidity in the Booster.

W.B.S. 1.8 Project Services

1.8.1 Project Management: In consultation with the DOE Project Manager $425,000 was assigned from contingency. This leaves a balance of $930,000 on $4,487,295 remaining to be expensed and committed. The details of these actions are outlined in section 3(f) and Table IV.

The operating schedule for the Booster accelerator has been extended again and now the start of Booster Modifications installation and completion of Conventional Construction have been rescheduled to June15 and July 31 respectively.

1.8.2 Fiscal: No change.

1.8.3 Environment, Safety and Health: Preparations for the Accelerator Readiness Review for BAF Commissioning continued on schedule during this reporting period.

Quality Assurance: No issues.

3) Summary Status Assessment and Forecast

a) Financial Status

A total of $28,482,705 was expensed or obligated of the $31,105,000 available. Costs represented $27,213,504 and open commitments stood at $1,269,201. The Project Total Estimated Cost (TEC) is $31,657,000. The Total Project Cost (TPC) is at $33,900,000.

b) Table II shows detailed expenses and commitments.

c) Table III shows the projected project spending profile.

d) Schedule Status

Milestones completed	Baseline	Actual
Title I Start	11/01/98	11/01/98
Booster Modification Start	04/01/99	04/01/99
Title II Start	04/01/99	04/01/99
Title I Complete	06/31/99	06/31/99
Conventional Construction-Start	08/15/99	08/15/99
Booster Penetration Complete	10/15/99	10/29/99
Title II Complete	06/30/00	06/30/00
Beam Transport Design-Complete	09/30/00	09/30/00
Booster Mod. Design-Complete	06/30/01	06/30/01
Safety Analysis Document (SAD) Complete	09/30/01	06/15/01

Milestones Upcoming	Baseline	Forecast
Conventional Construction Complete	06/30/02	07/31/02

d) The critical path for the Project is indicated in Figure 1. WBS 1.2 is now on the critical path. The majority of the items in this WBS can only be installed when the Booster is in a scheduled shutdown. The estimate for installation is 4 months, including time to allow "cool-down" of radioactive components. The FY 2002 Booster shutdown is now scheduled to begin June 15 and beam operations in the Booster are scheduled to resume November 1.

All items will be ready for installation before June15 and detailed installation plans have been developed.

e) Baseline Change Proposals – During this reporting period, the budgets for the following W.B.S.'s were augmented/decreased with transfer of funds to and from contingency. The justifications for the modifications are given in Table IV. There is no change in scope or total project cost.

WBS	Description	New Budget
1.1	Conventional Construction	$6,660,000
1.2.1	New Extraction Equipment	$1,672,000
1.3.1	Beam Transport Magnets	$1,089,000
1.7.1	Electric Power Distribution	$725,000
1.7.2	Equipment Cooling Water	$1,251,00
1.7.3	Installation	$1,545,000
1.8.4	ES&H	$347,000

g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations and expenses were $385,000 more than planned, and expenses were $311,000 lower than forecast. These differences are not significant at this stage of the Project.

Table I

BAF Project Milestones

	Projected
Project Start	10/01/98
Title I Start (Preliminary Design)	11/01/98
Booster Modification Design Start	04/01/99
Title II Start (Final Design)	04/01/99
Title I Complete	06/31/99
Conventional Construction Start	08/15/99
Booster Penetration Complete	10/15/99
Title II Complete	06/30/00
Booster Modifications Design Complete	06/30/01
Beam Transport System Design Complete	09/30/00
Safety Analysis document (SAD) Complete	09/30/01
Conventional Construction Complete	07/31/02
Booster Modifications Installation Complete	09/31/02
Beam Transport System Installation Complete	12/30/02
Experimental Equipment Installation Complete	03/31/03
Project Complete	06/30/03

Figure 1

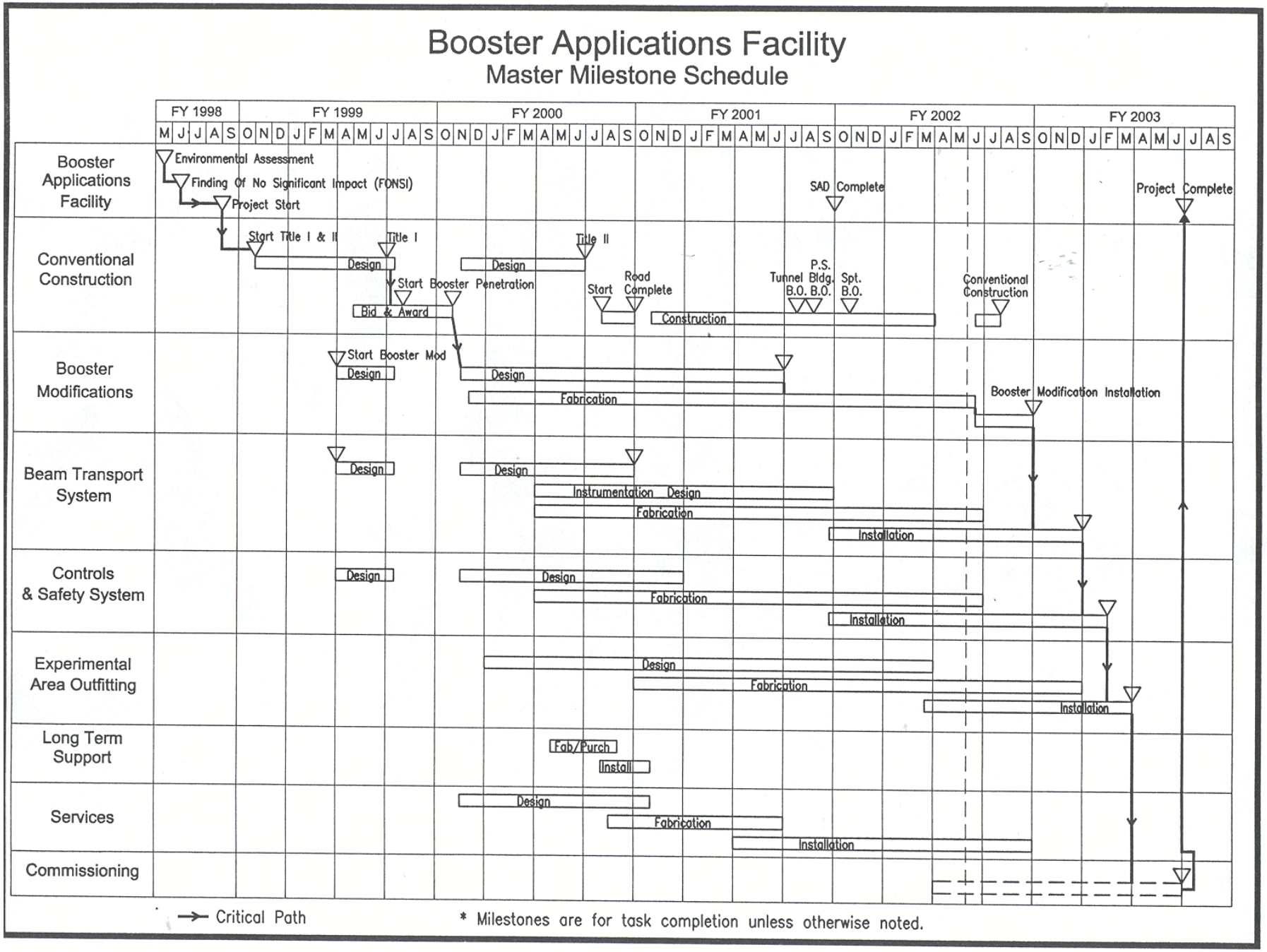
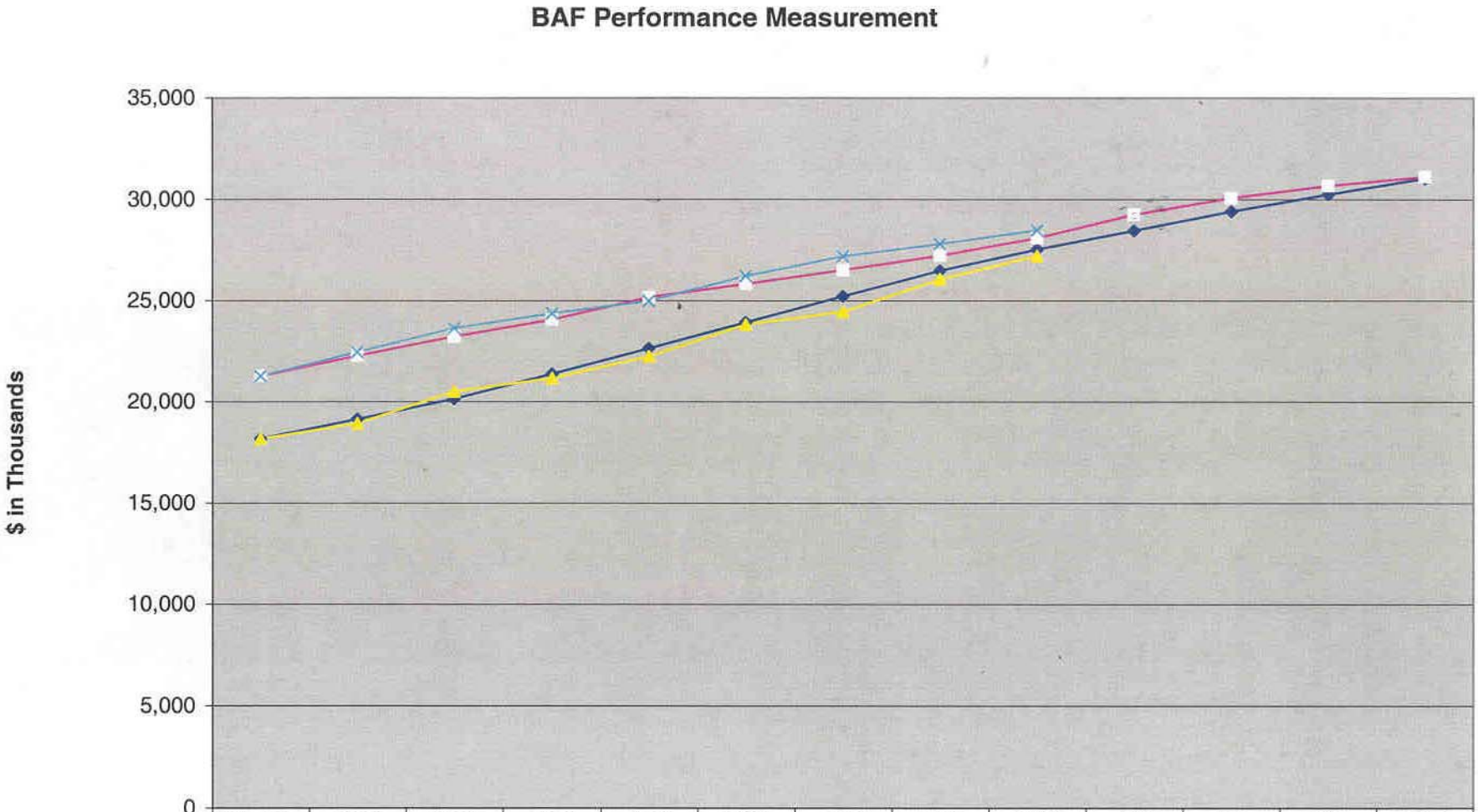

Booster Applications Facility
Master Milestone Schedule
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Booster Applications Facility
Environmental Assessment
Finding Of No Significant Impact (FONSI)
Project Start
SAD Complete
Project Complete
Conventional Construction
Start Title I & II
Title I
Design
Start Booster Penetration
Bid & Award
Title II
Design
Start
Road Complete
Construction
P.S. Tunnel B.O.
Bldg. B.O.
Spt. B.O.
Conventional Construction
Booster Modifications
Start Booster Mod
Design
Design
Fabrication
Booster Modification Installation
Beam Transport System
Design
Design
Instrumentation Design
Fabrication
Installation
Controls & Safety System
Design
Design
Fabrication
Installation
Experimental Area Outfitting
Design
Fabrication
Installation
Long Term Support
Fab/Purch
Install
Services
Design
Fabrication
Installation
Commissioning
Critical Path
* Milestones are for task completion unless otherwise noted.

Figure 2



	Prior Yrs	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
BCWS (BO)	18,180.0	19,135.0	20,130.0	21,375.0	22,635.0	23,920.0	25,205.0	26,490.0	27,525.0	28,460.0	29,395.0	30,245.0	31,037.8
BCWS (BA)	21,261.2	22,270.2	23,210.2	24,065.2	25,175.2	25,833.2	26,503.2	27,207.2	28,097.2	29,247.2	30,068.2	30,658.2	31,100.0
ACWP (BO)	18,180.0	18,941.9	20,504.2	21,163.0	22,244.0	23,834.4	24,457.4	26,052.5	27,213.5				
ACWP (BA)	21,261.2	22,451.0	23,637.5	24,374.1	24,988.6	26,212.6	27,179.1	27,791.7	28,482.7				

TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of May 31, 2002

	Budget	EXPENSES Salary & Wage	Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
1.1 Conventional Construction	6,660,000	133,094	987,963	4,782,771	580,164	6,483,992	168,634	6,652,626	67,374
1.2 Booster Modifications	5,701,000	1,830,520	556,268	2.004,132	872,194	5,263,114	141,777	5,404,891	296,109
1.3 Beam Transport System	5,629,000	1,816,290	324,861	1,766,856	756,699	4,664,706	351,572	5,016,278	612,722
1.4 Controls & Personnel Safety System	1,582,000	535,280	82,113	526,039	237,567	1,380,999	23,672	1,404,671	177,329
1.5 Exp. Area Outfitting	3,264,00	38,838	2,753	2,403,750	180,396	2,625,737	192,079	2,817,816	446,184
1.6 Long Term Support Lab	456,000		2,095	338,282	59,133	399,510	85	399,595	56,405
1.7 Installation & Services	3,521,000	903,962	245,242	1,801,842	437,642	3,388,688	67,699	3,456,387	35,387
1.8 Project Services	3,089,000	967,285	31,876	172,263	1,436,034	2,607,458	101,203	2,708,661	380,334
CONTINGECY	375,000					0		0	375,000
SPARES	653,000	30,504	68,360	234,448	65,988	399,300	222,480	621,780	31,220
Commissioning	175,000	0	0	0	0	0	0	0	175,000
1 BAF Construction	31,105,000	6,255,773	2,301,531	14,030,383	4,625,817	27,213,504	1,269,201	28,482,705	2,622,295

TABLE III
BOOSTER APPLICATIONS FACILITY (BAF)
COST ESTIMATE
Spending Profile
($ in Thousands)

WBS	ELEMENT	TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
1.1	Conventional Construction	6,660	290	80	4,628	989	673	0
1.2	Booster Modifications	5,701		282	1,747	1,886	1,786	0
1.3	Beam Transport System	5,629		56	961	2,547	2,065	0
1.4	Controls & Personnel Safety System	1,657		8	497	579	498	75
1.5	Exp. Area Outfitting	3,364		0	1,200	679	1,385	100
1.6	Long Term Support Lab	456		0	343	0	113	0
1.7	Installation & Services	3,521		9	1,237	1,117	1,158	0
1.8	Project Services	3,739	10	165	985	650	1,279	650
		30,727	300	600	11,598	8,447	8,957	650
	Contingency	930	0	0	0	0	375	555
1 (TEC)	BAF Construction (BA AY $)	31,657	300	600	11,598	8,447	9,332	1,205
	Spares	844			50	266	337	191
	Commissioning	1,399					175	1,224
1 (TPC)	Total Project Cost (BA AY $)	33,900	300	600	11,648	8,713	9,844	2,795
1 (TPC)	BAF Construction (BO AY $)	33,900	300	600	5,348	11,932	12,858	2,862

TABLE IV
BAF CHANGE CONTROL
$1000's

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
06/30/00	1	1.1		3,803	870	4,673			Modified WBS elements to include overhead, escalation and FCR.
		1.2		3,742	1,109	4,851			
		1.3		4,478	1,160	5,638			
		1.4		1,236	321	1,557			
		1.5		2,710	358	3,068			
		1.6		851	104	455			
		1.7		1,708	463	2,171			
		1.8		1,129	2,129	3,258			
			Contingency	3,796	1,037	4,833	4,833	4,833	
			Overhead	4,649	0	0			
			Escalation	1,912	0	0			
			FCR	993	0	0			
08/31/00	2	1.1		4,673	425	5,098	(425)	4,408	Vendor bid exceeded estimate
08/31/00	3	1.7		2,171	68	2,239	(68)	4,340	Vendor bid exceeded estimate
11/30/00	4	1.0		31,100	800	31,900	200	4,540	Modified spending profile to coincide with NASA operating plan
11/30/00	5	1.0		Changed Project Completion Date from 09/30/02 to 06/30/03					Modified schedule to match spending profile
11/30/00	6	1.3		Changed Completion Date from 04/31/02 to 09/30/02					Modified schedule to match spending profile
11/30/00	7	1.4		Changed Completion Date from 05/30/02 to 03/31/03					Modified schedule to match spending profile
11/30/00	8	1.5		Changed Completion Date from 06/30/02 to 03/31/03					Modified schedule to match spending profile
11/30/00	9	Commissioning		Changed Completion Date from 09/30/02 to 06/30/03					Modified schedule to match spending profile
11/30/00	10	1.1		5,098	600	5,698	(600)	3,940	Vendor Change orders to cover soil conditions, upgrading water line under beam tunnel & Plant Engineering oversight
11/30/00	11	1.2.1		1,322	200	1,522	(200)	3,740	Design effort exceeded estimate
11/30/00	12	1.2.2		1,982	200	2,182	(200)	3,540	Vendor bid exceeded estimate
11/30/00	13	1.7.1		353	200	553	(200)	3,340	Substation reconditioning more extensive than estimated

TABLE IV
BAF CHANGE CONTROL
$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
11/30/00	14	1.7.2		641	300	941	(300)	3,040	Detailed design increased cost
12/30/00	15	1.3.2		1,513	(250)	1,263	250	3,290	Vendor bids lower than estimate
12/30/00	16	1.3.4		2,007	(150)	1,857	150	3,440	Detailed design resulted in lower device costs
12/30/00	17	1.3.1		599	400	999	(400)	3,040	Vendor bids exceeded estimate, design effort exceeded estimate
12/30/00	18	1.2		Booster Modification Completion Date changed from 10/31/01 to 08/31/02					RHIC operating schedule modified, eliminating FY01 summer shutdown
01/20/01	19	1.2		Design complete extended from 12/31/00 to 06/30/01					Design effort extended due to loss of personnel
09/30/01	20	1.8		3,659	160	3,499	160	3,200	Reduced budget due to projected lower project burden and fiscal and FS&H expenses.
09/30/01	21	1.1		5,698	(200)	5,898	(200)	3,000	Increase engineering design effort for electrical distribution & building modifications
09/30/01	22	1.7		2,739	(160)	2,899	(160)	2,840	Increased budget required for higher than expected vendor bids
11/30/01	23	1.1		5,698	602	6,300	(602)	2,238	Increase required for HVAC controls, doors and canopy at alcove, HVAC duct work, structural steel work, berm liner, engineering and inspection and overhead costs increases.
11/30/01	24	1.2		5,251	100	5,351	(100)	2,138	Increase required for D3 septum development and buss work fabrication for D3 and D6 power supply installation.
11/30/01	25	1.3.1		999	25	1,024	(25)	2,113	Increase required for magnet monitoring system and octupoles.
11/30/01	26	1.7		2,899	197	3,096	(197)	1,916	Increase required for electrical distribution system transformer rework and cooling system changes for power supplies.
01/31/02	27	1.1		6,300	300	6,600	(300)	1,616	Increased cost for engineering oversight.

TABLE IV
BAF CHANGE CONTROL
$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
01/31/02	28	1.2.1		1,472	100	1,572	(100)	1,516	Development and manufacturing costs exceeded estimates.
01/31/02	29	1.2.3		1,547	200	1,347	200	1,716	Design and manufacturing costs lower than estimate.
01/31/02	30	1.3.1		1,024	200	1,224	(200)	1,516	Fabrication and procurement exceeded estimate.
01/31/02	31	1.3.2		1,263	300	963	300	1,816	Procurement costs lower than estimate.
01/31/02	32	1.3.3		1,620	100	1,720	(100)	1,716	Fabrication costs exceeded estimate.
01/31/02	33	1.4.2		486	100	586	(100)	1,616	Design change added costs to building access system.
3/31/02	34	1.2.1		1,572	50	1,622	(50)	1,566	Cover increased manufacturing costs for thin septum magnet
3/31/02	35	1.2.2		2,532	150	2,682	(150)	1,416	Cover installation effort and materials for power supplies
3/31/02	36	1.5.1		2,706	296	3,002	(296)	1,120	Additional software and hardware effort required to complete Dosimetry system
3/31/02	37	1.7.3		1,245	50	1,295	(50)	1,070	Increased effort in survey and installation coordination
3/31/02	38	1.8.4		122	165	287	(165)	905	Funding to re-rout storm line located under Booster B 6 Dump
3/31/02	39	Spares		1,294	450	844	450	1,355	Spares estimate more than as built shops and manufacturer's costs
5/31/02	40	1.1		6,600	60	6,660	(60)	1,295	Cost increase for retaining wall
5/31/02	41	1.2.1		1,622	50	1,672	(50)	1,245	Magnet measurement cost increase
5/31/02	42	1.3.1		1,816	(135)	1,681	135	1,380	Magnet system came in under budget
5/31/02	43	1.7.1		700	25	725	(25)	1,355	Re-installation of repaired transformer
5/31/02	44	1.7.2		1,151	100	1,251	(100)	1,255	Control system cost increases
5/31/02	45	1.7.3		1,295	250	1,545	(250)	1,005	Rigging and survey costs exceeded estimates
5/31/02	46	1.8.4		287	75	362	(75)	930	Beam dump cap under estimated